

COCKPIT RESOURCE MANAGEMENT
AND THE THEORY OF THE SITUATION

Lee Bolman

Harvard University

DR. BOLMAN: Thank you, John. It is a pleasure to be here. It's the second time that I have addressed an industry conference in the airline industry, and I think I'm not quite as terrified as I was the first time, but I still feel a considerable amount of apprehension. I have several strikes against me. One is that I'm not a pilot. The bulk of my airline experience is the nonsmoking aisle seat and you don't really learn a heck of a lot about flying in that situation.

The second is that the bulk of my cockpit experience has been with major airlines, (Ed Carroll knows a lot about some of that experience) in large airplanes usually with three-man crews. I've had much less experience with the commuter industry. So I hope you will bear that in mind and try to make appropriate translations from the experience I have had to the situations that you know well.

The third strike is that my industry experience has been as a consultant, and that doesn't add to my credibility. Most of you probably are familiar with the definition of a consultant as someone who borrows your watch, tells you the time, and keeps the watch. Some of you may have had the experiences that confirm such impressions.

There should be some points of tangency, and I hope no major contradictions with what Ed Carroll was describing yesterday as he was talking about some ideas that I find helpful in trying to approach the question of cockpit resource management. I suspect that Ed's is more concrete, more practical, as you'd expect from someone with Ed's experience. My approach will be more general and will sound more like a lecture from a college professor.

The way I'd like to begin is to talk about two different kinds of error. Jack was talking about risk, and there's a relationship, I think, between his discussion and what I mean when I talk about error. Error in general has to do with a mismatch between what you want and what you get. There's something we're trying to achieve, and somehow whatever we produce is not what we had in mind. And I want to talk about two different kinds of error, because I think

one is better understood, and our training, in general, does a better job with it.

Error of execution is what happens when you know where you're trying to get and you know pretty much how you're supposed to get there, but somehow there's a lapse in the attempt to produce whatever you have in mind. I had a fair amount of jump seat experience over a few years, and I remember the worst jump seat landing I ever experienced. It was a case of a transitioning co-pilot who had been bumped down from one aircraft to another. He was flying with a check pilot and the conversation between the two of them made it clear that, so far, every landing that he had made had been fairly terrible. As they were on the approach, they reviewed the whole thing again, and the co-pilot said he understood, he knew what he was going to do. He came in too high, too fast, and poorly configured. That's an error of execution. The co-pilot had extensive experience landing airplanes. Presumably he knew how to land the airplane he had transitioned from and was comfortable doing that. With a few more landings, I imagine that he learned how to do well on the new one. He knew what he wanted - he just had trouble making it come out right. That's an error of execution.

Now, there is another kind of error, and that may be less common, but has become more important as we've gotten better at dealing with the first kind. I'll call the second type an error in the theory that you have about the situation. There's an old saying that there is nothing so practical as a good theory. This is not an idea that's widespread outside of the universities, but I think that it contains an important truth. In any situation in life, we act on the basis of our theories about what is going on around us. When I first started looking at what happens in cockpits, I spent a lot of time looking at NTSB accident reports. I still find those to be a fascinating source of information about both flying and human decision making. When I first started looking at them, one of the things I began to notice in a lot of accidents, was that part of the problem was that the crew was trying to put together different pieces of information, various and assorted pieces of data, frequently under situations where they didn't all fit together into some coherent view of what was happening. In many of the accidents, what was happening was not that they solved the problem incorrectly, but they were solving the wrong problem. They had the wrong theory about what was occurring to the airplane. To give you just one example, I think a 727 was lost in a situation where somehow the crew had missed the pitot heater on the checklist. During climb the crew noticed unusually high airspeed readings. I'm going to exaggerate this a little bit, but the crew got into this fascinating conversation about gee, why in the hell are

we going so fast, isn't it amazing? And then they began to develop theories to account for why they're going so fast -- the plane was empty, the weather conditions were unusual and so on. A little later they went into a stall, which they misinterpreted as a mach buffet. If you think you're going very fast when your airplane is going to stall, you don't take the right actions. The crew's actions were right for the problem they thought they had, but they were solving the wrong problem. That can occur in situations where the problem is making sure we've defined the right problem. Once we've defined the right problem, then we go on to the problem of how do we solve it.

Now, it seems to me if we think of this as Type A and Type B, that most of the training that commercial pilots get is around issues of execution, training them to solve the problems that we understand well. And I think well over 90 percent of the situations that pilots encounter are of that nature. It's fairly straightforward. Much of flying is not only routine, but it gets dull. The problems are clear, what needs to be done is clear, it's just a question of knowing how to do it skillfully and professionally. I think our training has done a tremendous job in these areas. It's hard to achieve perfection when you're talking about humans, but we've done well on Type A problems. I think very little of our energy has been on Type B, partially because it's less obvious. It's something that's more obscure and it takes awhile to begin to get a sense of the difference between solving a problem and defining a problem.

So, in my initial efforts to try to understand the issues of cockpit resource management, I came to the idea that pilots are always in the process of developing what I call a theory of the situation. And a theory of the situation is basically a set of ideas that I have in my head that says what's happening right now, what's happening in my airplane, what's happening in the cockpit, what needs to happen under these circumstances. It's that theory about the situation that's going to influence our actions. I'll do what I think is sensible given the conditions.

One thing that I've been trying to understand is when is it most likely that pilot will have the wrong theory -- will be operating under the basis of the wrong assumptions about what is happening. I've been helped in this by some of the reports out of the ASRS system. It's a wonderful database. It seems to me that there's a set of conditions -- major conditions that lead people to get off track. One set of conditions is distraction. There is something happening that is pulling pilots attention away from the critical operational issues. One example that I always remember is the very chatty jump seating captain in the PSA accident at San Diego. While the crew was getting reports

about the possibility of traffic conflicts, there was a captain in the jump seat talking with considerable intensity about the company benefits programs. That could not possibly have been a helpful factor in that situation. It might have been a critical distraction that kept the crew from focusing on more critical operational issues. There has been a series of similar incidents and accidents. Sometimes it's a systems malfunction, sometimes it's in the cockpit, sometimes it's a confusing ATC message. It can even come from the cabin. Something is distracting the crew and making it more difficult for them to function, to do what they really need to be dealing with.

A second set of conditions has to do with stress or high work load. Some of the work that NASA's done in this area makes it very clear that as the work load expands it gets more likely that the work exceeds the capacity of the crew to manage it. The crew gets into trouble, and begins to have the wrong ideas about what's happening.

A third set of conditions I think have to do with Jack's phrase about ignorance and a need to push on. One kind of situation that is often troublesome is where the crew has experienced a fair amount of frustration. One of the clearest examples is delays. I was in an airplane earlier this summer on a day in which I think there were thunderstorms at every airport in the United States. We sat on the ground for almost two hours, and you could tell the captain was getting more and more frustrated. We were going from New York to Dallas, and the weather was bad at both. The guy was getting more and more angry. He finally got a clearance for pushback and he wasn't able to pushback because maintenance was having problems. He was furious because of that. By the time maintenance was ready, ground control had stopped issuing pushback clearances. They asked him was he pushed back, and he said yes, indeed, he certainly was, even though he was still at the gate. The reports suggested that this was a doubtful situation to even take off, what seemed to happen was the right stuff was coming out. This guy's fighter pilot experience was beginning to really take hold, and it was like it didn't matter, what the hell, he was going to get that airplane out of Kennedy and into the air no matter how many lines of thunderstorms there were. It was an interesting experience. It's not that the risk he ran was huge, but he sure as hell was expanding the risk beyond what anybody in the airplane, I think, would have wanted him to do. And I think a lot of it had to do with he had just spent too many hours getting too frustrated and annoyed, and he was going to push on, whatever it took.

Now, a fourth set of conditions is ambiguous or misleading information. That covers a broad range of

circumstances, but it occurs a lot in the aviation situation. Sometimes you get misleading information, like a misleading clearance. Sometimes you have incomplete information, and sometimes you're trying to put together several different pieces of data. You usually can't just simply look out the cockpit window and know everything that you need to know. And you can wind up with a problem as you try to put together all the different pieces of information. A classic example is the TWA accident at Round Hill. They were headed into Dulles and they received an initial approach clearance. The captain looked at his approach chart and said "You know this dumb chart says 3400 to Round Hill." He had a moment of doubt whether to go to 1800 or maintain 3400. But he decided that the controller presumably knew what he said. The crew continued to have a conversation in the cockpit and decided to keep on going down and ran into the mountain. That's one of many situations where the information is either misleading or ambiguous. Whenever you have misleading or ambiguous information, you're faced with uncertainty. If you have uncertainty and you have to take action, then inevitably what you have to do is to develop some way of resolving uncertainty, and you develop a theory that makes sense of it all. If your theory is right, your action will be right; if your theory is wrong, your action will be wrong.

You have a possibility that could happen any time, although it's more likely to happen sometimes than others, that pilots can suddenly get off the wrong track where their theory simply doesn't fit with the reality of the situation. That has implications for how we think about the responsibility that we have in developing effective pilots and developing training that will make them so. And it means in addition to all of the things that we have done in the past to help them learn the operational skills and the systems knowledge and everything else that's critical to a good professional we also face another set of issues that are more difficult to deal with because what we're really talking about here is the residual uncertainty. It's everything that we don't yet understand well. And that includes the unusual set of circumstances, the surprising circumstances, the situation that nobody ever was quite able to anticipate, or all the places where something has gone wrong so now there's uncertainty in the environment and the crew has to find some way to negotiate through that uncertainty. And training programs have really, I think, put little emphasis on how do you train people to deal with uncertainty.

There is a second major factor that contributes, I think, to errors. I was impressed when I first started working with pilots that in certain ways they're just like other managers. The bulk of my work has been working with

managers around how you lead effectively or how do you manage well. I never thought until I looked at it that in some ways what goes on in a cockpit is very parallel, even though in some ways it's very different. And one very significant parallel has to do with one of the most universal phenomena that we have found in working with managers. Let me introduce it with a little story.

This goes back ten years. A colleague of mine was doing a seminar on leadership for chief executives in medium size companies, and we had a group of ten such people who were going to come to a two and a half day seminar on how do you lead medium size companies. And we knew that in working with this kind of group, a very high power, very demanding group, they would come and say, "Show us something good." If it wasn't good, we'd be in trouble. We figured we needed something that would make sense to them, that they would consider was credible and went beyond a few crazy ideas from academicians. So we asked each of them -- each was president of a medium size company -- to send us a tape recording of him leading a meeting. We said you choose the meeting, just give us something that you think is representative of your leadership in your organization. From each of them we got one of these recordings, and we went through them, and we did a little bit of what Bill was saying ASRS does with their reports, we de-identified them. We took out the name of the company, the names of the people, and all of the specifics of a situation, and we made up type scripts, not the whole tape, because an hour's worth of tape is a lot of pages, but we made about 20 and 25 page cases for each of these ten people of excerpts out of the meetings. And we labeled them Case A, Case B, Case C, and so on. They arrived at the conference, they got little loose-leaf binders with these cases in them, they went off to their rooms, and they read them with fascination. It may not sound like the most exciting way to spend an evening, but these guys thought it was terrific. They really just dug into that and read late into the night.

There were a variety of reasons why they were fascinated, a couple of which we hadn't predicted, but we've found since were not unique. One was that in every case where they'd ever met each other they could identify each other's cases. Not all of them knew each other, but a number of them had met through trade groups or conventions and so on. They didn't know each other well, but in every case where they'd ever met, they were able to identify each other's cases.

Query, how did they do that? What do you think? Style is the answer. That is, in every case the individual's management style was like a behavioral footprint, and wherever the person went, you could see that behavioral

footprint and could say "aha this is so and so." In some cases it was dramatically clear -- we had one guy whose way of leading at meetings was blame and kick ass, I guess would be a way of looking at it, or shout and kick ass: "Goddam it, Tommy, you act" -- as he's talking to his vice president -- "you act like I'm asking you to climb Mt. Everest. I'm telling you these are the sales targets and you're going to meet them." So everybody looked at that and said hey, that's Alan, who else would lead a meeting like that. Other cases were more subtle, but what was interesting was that they were able to see it.

Now, if you can do that, what does it tell you? It tells you that there's a tremendous amount of stability in that behavioral footprint, that people's behavioral footprint shows substantial consistency over a period of time, and you can track them. So that was the first thing that was interesting.

The second thing that was interesting was that to a man it was absolutely unanimous after reading all the cases they had this exhilarating feeling that was sort of "Thank God, I produced the one example of effective leadership." They were all sincerely convinced, and at the same time, they were amazed at how bad some of these other guys were. They were thinking, "I'm surprised the company makes money the way this guy leads meetings. How can they ever make a decent decision. This is terrible."

So we did the seminar by going through a case at a time, and for about the first three or four cases, each time we'd start up, the guy who'd present it, would just sort of briefly describe the situation and talk and say a few things about, "Well, as you know, I probably didn't do this quite as well as I could have, but overall I feel pretty good about it." And then he would sit and smile waiting for the compliments to come. And they never came. It took about three or four of those before people began to see that there was a pattern that was establishing itself. Each of the people was hoping for the accolade. He wasn't going to get it.

One of the things that they realized as a result of that seminar was that there was a lot about what they did that was standard, it was absolutely predictable, but the individual didn't know it. That is, they didn't really know about their own leadership style, even though their leadership style was well developed and had been known to others for a long time.

Well, as I've talked to pilots, the same situation, I think, is true. It's as true of airline pilots as it is of other people, that there are a variety of situations in

which we think we know what we're doing and really don't. It is most likely to occur in a couple of conditions. One is when we are under stress. One of the things we know is that when a person is under stress, they are more likely to be doing something that is different from what they think they're doing. A tremendous amount of error under stressful conditions occurs because people simply aren't doing what they thought they were.

Secondly, it's more likely to occur in the more ambiguous, softer, more subjective areas like management style. It's less likely to occur in concrete, easy to define skill areas. So that if you apply that to pilots, what it suggests is that because of the sophistication that pilot training has achieved for many of the basic skills that pilots need to have -- in fact, they know what they're doing. If they don't they find it out every time they go back for the recurrent training. A simulator can tell you a lot about whether or not you're doing what you think you're doing. But when you get into the areas of communications, of resource management, the area of information transfer, of how we take in information and how we communicate information to others around us, the probabilities are much higher that, in fact, pilots are unaware of what they do. Now, this has become critical in a number of both incidents and accidents. One place it shows up is in the large number of cases in which the captain was headed down a particular path. Someone in the cockpit, at least knew, and in some cases tried to give a hint to the captain that maybe the path he was headed down was not the right one. You're probably all familiar with a variety of those, like the accident in Mexico City. The captain tried to land on one runway, and the co-pilot was trying to tell him, "Hey, you're not headed in the right direction." There are many similar accidents. And if you ask why those occur, it's very interesting. If you read accident reports, you find a series of situations in which the captain isn't listening, and frequently the junior crew members aren't talking very clearly, so it's a two-sided situation. The captain isn't really trying very hard to learn what other people have to say, and often they're being very careful or very guarded about what it is they're trying to get through to the captain.

Now, I've talked to a lot of captains about that, and I've talked to a lot of co-pilots about that, and all the ones I've talked to wouldn't make those mistakes. They're absolutely sure they wouldn't do it. In fact, I talked to a lot of captains about their leadership style, and all of them are well above average leaders. I've never run into a below average leader. I've also talked to some of the junior crew members of some of those above average leaders who don't agree that, in fact, they're dealing with an above

average leader. In other cases they do agree. That is, there are cases where the captain's confidence in his own leadership is well validated by the people around him. But one of the things that I've seen repeatedly is cases where the way the captain talks about how he leads, and how he manages the crew is not what I see as I watch him fly, and it's not what his junior crew members see as they watch him fly. And that kind of gap, that inconsistency between what the captain thinks he's doing and particularly how he thinks he's leading is one of the things that produces the problem.

I've talked to a lot of junior crew members about these cases where the captain flew into disaster and the junior crew was kind of shy about bringing it up. Again, the people I've talked to wouldn't let that happen. I mean, they're very, very clear about this. You know, "Hey my ass goes with his, no way I'm going to let that son of a bitch fly me into the ground." And one of the issues that comes up here is well, if nobody would do it, why does it happen? And I think part of why it happens is that in terms of our own perceptions of ourselves, our espoused theory about ourselves, all of us believe that what we would do under those circumstances would be effective. For many of us we're right, and for some of us we're not right. Unless we're given some help somewhere through the training program that we undertake in the course of developing our piloting skills, it may be that we'll never learn for sure until we're in a critical situation, and then it's too late.

That's led me to think that the whole area of cockpit resource management is, in fact, one of the last major frontiers in aviation safety. The kinds of training that we give pilots needs to take account of both of the major issues that I've talked about. One has to do with training pilots to be alert to the possibility that there will be times when you may have the wrong set of assumptions about what is going on, and for them to be alert to a couple of things. One is the clues that maybe you have the wrong theory about what is going on. In most of the cases that I've seen one or both of two clues is present. One is anomaly -- all the information doesn't add up, there's some piece of data that's inconsistent with your view of what's going on. In many of the cases where pilots are operating on the wrong assumptions, there's some kind of anomaly occurring. Another thing is some kind of challenge or at least nudge from other members of the crew that maybe what you're doing is off target. In most of the situations where people have gone off on the wrong program, one or both of those things was present. And in order for that kind of accident to become less common, I think one thing that needs to happen is all pilots need to be more aware that they make mistakes, to get beyond the assumption that to make one is the wrong thing. "I never want anybody to see it, and by

God, if anybody ever tries to tell me that I made one, I'll tell them about what a good pilot I am."

The second is to make it part of standard practice within cockpits that everybody assumes that part of our job is to help each other make sure that we don't do that, and that as a senior crew member in a cockpit, I have an absolute obligation to try to make sure that I utilize any information the junior crew members can provide. As a junior crew member, if I think there is a problem, I have an obligation to make sure that the captain has an opportunity to use that information.

I think that over time it's going to become essential for all of the carriers to develop more objective ways of approaching this issue. The most developed program that I am familiar with is United's effort. I'm probably more independent in this area than Ed is. He and I did not always agree. The program basically has several major elements to it. It began with a home-study course-- a set of written materials for pilots to read. I think that had some degree of utility in getting people familiar with the area, although, as Jack was saying earlier, there is the horse-watering problem. It's a real one here in terms of getting pilots to read very deeply the topic in their spare time. So if you use written material, it needs to be stuff that is interesting enough and attractive enough that they're willing to read it. But that's only a small start, because at most, it can get people thinking differently about the issue.

Part of the problem has been that it's been gradually dawning on many in the industry that the issue is really important. Even in the past year when I've talked to pilots, there are still a number of pilots who are yet to be convinced of the importance. There are far more believers than there were years ago, but there are still some skeptics.

The second part of the program that United developed involved bringing people together in seminars to get them looking at the issues of command and leadership and looking at themselves as commanders and leaders. Participants get feedback from fellow pilots about how they really lead. And I think that's a tremendously useful idea. Not that you have to do it the way United does it, but you need something that gets people into a setting where they work with fellow pilots and look seriously at issues of leadership in the cockpit. How do you make decisions in the cockpit? How can we do that better? And so look seriously at myself and what is my approach to managing the cockpit. I think that's important.

The final part of what United is doing, and I think it's the part that is really critical -- I think you could drop almost anything else, and if you'll do the last part well, that's where the basic learning needs to occur -- is to begin to integrate leadership, command, and resource management into recurrent training, and particularly to bring it into the LOFT scenarios. United's ability to get the pilots to sit still for the video in the simulators was a key step. When people were first talking about it, it wasn't at all clear that that could ever happen. I was so delighted that they were able to develop enough trust between the management and the pilots in that particular situation to convince them that it was going to be used in a way similar to what ASRS is for. That the purpose is not to punish you. The purpose is to convey some information that can be tremendously useful for your learning. More than 95 percent of the situations that occur in an airline cockpit really don't present the key management questions: Do you have the right problem defined? Do you really have the right theory about what's going on? They mostly occur in those very difficult high stress situations.

The nice thing about the simulator is that you can create those same situations where people are most likely to make the kinds of errors that I've been talking about. Those are the situations in which people are most likely not to do what they think they're doing. My favorite example of this is I was watching a crew going through the simulator check, and the captain had been asked had he had much experience with the coupled monitored approach. And he said no, he really hadn't. And the instructor, "You should try it." So the captain and the co-pilot talked about how they were going to do this. "When we reach decision height", said the Captain, I'll either say "go around," or "I've got it." The co-pilot said, "Fine." As they made the approach, everything was going very well. They reached decision height. The captain looked out the window and said, in his best command voice, "Land the airplane." The co-pilot was not expecting that particular instruction -- he knew that wasn't what was supposed to happen, so he looked at the captain. The captain looked back at him. They looked at each other while the simulator continued to descend. Finally the captain said, "Whoops, okay, I've got it." He landed the simulator okay, but it was not exactly how they wanted it to happen.

It was a case in which the captain was absolutely clear in advance about what he was going to do. He said, here's what I'll do, but when he got into the actual situation he didn't do it. Particularly when you have some record of it that the pilots are able to look at, the simulator provides people that opportunity to really see themselves in action in the most difficult situations that they're likely to

encounter.

I think that the set of issues that you're trying to address here are critical. I am always impressed at the difficulties of developing effective approaches to the problem, particularly because of the economic constraints that I have felt are far and away the biggest problem to really do this well. I think we are getting a much better handle on the problem. I think we've learned a tremendous amount about how to better train in these areas, and I think that primarily the thing that gets in the way is to be able to free up enough of the resources so that we can really do the kind of training that's necessary. As Jack was saying earlier, the converse of that same coin is that the costs of an accident are much, much higher; so I think it's worth the investment.

Let me see if there are questions.

DISCUSSION

CAPT. BENTHAM: Jack Bentham, Metro Airlines. Could you go through some of the suggestions that you made to United that they did not include in their program? This is not to critique your United involvement as much as the fact that there are a lot of people in the audience that I think are beginning to formulate their plans and could really use your expertise in your involvement.

DR. BOLMAN: What a great question! I mean that is a good question. There are several different levels. Now some of the ones I threw out, for example, every once in awhile I would write Ed with this great idea for some research that they could do, and I tended to have trouble convincing him of that, that it was going to be expensive and so on. I would guess the major point where we most often disagreed was United had a commitment that was historical to the management grid. A lot of United management had experienced management grid and it made sense to them since the language and the concepts were already very familiar among the United managers. So they chose to introduce that into the flight training situation as well. I always had an uneasiness that the grid people, not the United people, but the grid people had faith that the grid applies everywhere, and that it wasn't always easy to get them to ask, "Wait a minute, are there parts of our theory that maybe don't fit quite as well for the very specialized nature of the aviation cockpit." I thought that United people who worked with them did a tremendous job of educating them. Initially, it was as if they were on

opposite sides of a bridge. The grid people knew a lot about grid, and the United people knew a lot about flying, and for awhile, I think the grid people kept saying, "You come over here and it will all be fine," and the United people said "Wait a minute." So I would guess that that's been the major place where we didn't always agree. I would probably have wanted to massage that theory more than it's been massaged too. There are some aspects of the theory that probably fit fine when you're talking about middle or senior managers in an oil company, but I think the cockpit is special. A lot of those ideas are appropriate, but they really need to be adapted carefully to the specifics of the situation.

CAPT. CARROLL: What Lee has said is absolutely correct, and I think the only explanation I would make in this regard is to carry what he said one step further. We told the people from SMI that what we wanted to use the grid for a frame of reference of the language that was easily identifiable through the population because we were addressing a new area of interest and concern for the pilots. So what we have constantly said and we have been successful, is that we did not want to run a grid seminar, we wanted to run a flight operations cockpit resource management seminar based upon the grid of a frame of reference, a language. As an example, as Lee well points out, we had a history of using the grid in the company, but it runs five and a half days. Ours only runs three and a half, so you can see where you have not emasculated it, but at least we've adapted it to our needs. And to the people who have been through it, both in our company, and I think commercially, I think they would readily identify with what Lee said. We had to cross that bridge and get them to recognize what we were doing and not have a middle management approach. They participate with us in all of the seminars, but credibility of the seminar is, I think, in the hands of the operations people who run the seminar. They're there for theory clarification, but they're really background people to what we're doing, and Lee is absolutely correct. In fact, to give him credit for his disagreement with me -- and it's amazing to get a letter from a Harvard professor and then correct it for him, you know --

DR. BOLMAN: Ed is known around United as the great editor.

CAPT. CARROLL: And I didn't want to be inconsistent with Harvard either. We put out seven books, and Lee has always taken great delight in this. The last one was just reference material, but the first six were the education. We got critiques back from that cross-section of people who studied it for us before we gave it to the whole population, and they said books one to five obviously have been written

by some Harvard egghead, and you ought to throw all that material away, and book six is the only one that really has any credibility. The only one that Lee really had a tremendous input into was book six.

DR. BOLMAN: Some people said that sounded like it was written by somebody who understood the pilot -- the cockpit environment. I do take pride in that to this day. I'm not sure how it happened.

MR. FISCHER: Bob Fischer from Summit. You addressed indirectly the concept of self image that the captain probably has and the first officer and the flight engineer, if it's a three man cockpit. Would you distinguish what we define as the manager versus the leader? I think they're two different things in some cases, and I think our technically qualified captain with numerous years of experience has learned to rely on himself, and basically is a leader. Now we're asking him to be a manager of resources which have always perhaps been there, but suddenly we have a more advanced technological cockpit and we're asking him to be a manager, and maybe he's not prepared to be a manager. Wouldn't he revert back to being a leader under a stressful situation?

DR. BOLMAN: Well, I think certainly he's likely to revert back to whatever he learned earlier. One of the things we know about being under stress is that we tend to revert back to whatever is easiest and learned earliest and we're most comfortable doing. The question -- that is a question that I get asked a lot, and it's, what's the difference between leadership and management? There's a lot written about it and nobody agrees. There's all kinds of definitions of both. Some people give you definitions of both. Some people give you definitions for management that sound like other people's definition of leadership. The way I generally think about it is I think about leadership as the capacity to attract the support and energy of whoever it is I'm trying to lead, to get them moving in the direction that I need to have happen. I think some of the traditional notions of command, which have military history and so on, don't always work effectively as ways of leading in the current environment because there have been cultural changes and people's notions of good leadership are changing. But I think there are also issues of management that go beyond being clear about the management issues. For instance, NASA did a study, the Ruffell-Smith Study -- I don't know if that's been talked about at this program, but they put pilots under high work load situations and one of the things they found was that very often you'd get into situations where the work load was very uneven across the three members of the crew. Now, it's a management task of the captain to solve that problem. And a lot of cases they got into a lot

of trouble in a situation where the captains, under very difficult circumstances, was both flying the plane himself, by hand, (because they didn't have an autopilot,) and making all the decisions, and the co-pilot was sitting there, trying to calculate the fuel dump so that the result was tremendously poor use of the resources. That's a managerial function, I think for the captain to be aware of. My guess is most captains have not been trained in that, and many of them probably aren't very clear about that, about the need to be aware of who's doing what and how do we make sure we're making the best possible use of the resources that we have available.

MR. PITTMAN: Hank Pittman, Reflectone. Isn't there a gray area, isn't there an area where you will actually, let's say, put a niche in the armor or the confidence level of the captain? Is there a point, and have we looked at that point, where perhaps he will over-analyze the situation and not react to make the decision he should have made?

DR. BOLMAN: Yes. That's a tough question, and I don't think I fully know the answer to that. I've been impressed in a tremendous number of the events that I've looked at that there was quite a bit of time to do some analysis, and in the ones I've seen, I can't think of an example where there was too much. I can think of a lot where there was too little, that is, where the crew didn't spend some time that really was available to them to rethink the situation. In a lot of those cases it seems to me what they could have done is try to collect more information from the controller, from the company, from somebody to fill in the missing blanks -- they had blanks in the picture, they weren't quite certain -- it didn't all add up to a coherent picture. I know the concern you're raising. Can the captain become too analytic? Another version of the concern I've heard is, "Can you undermine the authority structure in the cockpit?" And I think that's a real tension. How do you maintain the authority structure so that you have a clear decision-making system when you need it, and at the same time, get away from some of the potential harmful aspects of suppressing suppressing the resource that the junior crew members have. I don't think that's an easy one to deal with. I know the people at United wrestled with that a lot. It gets particularly tricky in issues like when do you take control from a captain. So there are some very tough issues there. My sense is, though, that it is possible to develop a set of understandings about that. If the captain and the co-pilot are both on the same wave length you can begin to get closer to having SOP's for command issues. For instance if the co-pilot thinks there's a problem, he has a responsibility to say so; the captain has certain obligations in terms of how he responds to that, and if they both understand that, and that's become practice for them, they know how to do it,

then I think that problem is less likely to occur. I don't know. If we ever see an accident where it's clear that's occurring, then I'll want to look very hard at that. I guess we probably should look harder at it even sooner than that. It's a good question.

MR. HAMPSON: Brian Hampson, CAE. Have you looked upon this question at all from a National point of view, the National characteristics? In the United States you don't have the rigid class structure which is still apparent in the United Kingdom, and they have the same type of thing in the National characteristics in the Far East where loss of face is a considerable problem you have looked at it from that point of view at all?

DR. BOLMAN: I've thought about it, mostly in the course of reading things like some of the accident reports, for example, of Japan Airlines, and my sense is, you're right, there's a real difference there, and that that difference would need to be factored into any approach dealing with the issues. In some of the Asian carriers I think it makes the problem worse in that it's harder for junior crew members to respond.

ED, do you want to comment on that?

CAPT. CARROLL: I have to compliment the gentleman from CAE for raising that question, because it is something that I have been confronted with just this month. I came back from Japan, and Japan Airlines, as you all know, has had a couple of accidents that have really concerned them. They replaced all of their top flight operations people after the Tokyo Bay accident. They have a new wave of people in there, and part of the new wave is a younger group in their late thirties and early forties who are in management positions now. They speak a little better English, they have a better understanding of the aviation world, and when I met with them for a full day and discussed this for eight hours with them, they asked me what I thought of their culture, and in the grid language, we -- I told them I thought they had a five five culture with a one nine backup. Now for you people that don't know what that means, is it means that they're in a compromising position all the time where no one really has to take a firm position, they arrive at not the best solution, but they get one everybody can buy into, if not commit to, and when all that doesn't work, then they try to be friendly and hurt no one's feelings because everyone will lose face. They accepted that very brief analysis and they also accepted the fact that it does not fit in the cockpit if you're going to have a universal safe approach to things. They are wrestling with their cultural approach as to how to do this, because they recognize that it is a universal problem. And we in this country have it

for all the reasons that Lee has pointed out, but I think these are the kind of things you do have to take a look at, and whether it's culture, whether it's crew size, whatever, it's all still essentially the same problem.

DR. BOLMAN: Thank you, Ed, and thank you all for the opportunity to talk to you.

DR. LAUBER: And thank you again, Lee, for another outstanding presentation.

Well, the time has come for you people to go to work and to take advantage of the ideas and concepts and new ways of thinking about some of the old problems that have been brought to your attention yesterday and this morning. You might view the rest of the day as being an opportunity to augment your own resources in that you have the opportunity to have other people from situations not unlike your own to tackle some of your own problems. What we're trying to achieve with all of this is a series of concrete recommendations, definition of issues, approaches, and identification of resources that are available to help you solve problems that will be assembled as part of the conference proceedings that will serve as a resource book of guidelines that people like yourselves can apply to solving your own particular training problems.

So the real product of this workshop is going to come in the next few hours from your efforts in these working groups. You've all been assigned to working groups. As you know, each working group has a chairman from your industry and a NASA co-chair. We discussed how the working groups will operate and how you're going to attempt to converge on a solution to your problem which is best stated as being able to come up with a good, high quality substantive report which representatives of your group will be presenting when we get together back here tomorrow morning.

Good luck and work hard.